



# MEMORY ALTERATION

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## ABSTRACT

In media, many people view memory-altering technologies as science fiction or used for manipulative reasons, but their impacts and implementations are deeper than that. When we face traumatic experiences and events, our brain takes a long time to recover. There are many different side effects and coping mechanisms which are still being researched and observed. Some of these side effects go as far as unintentionally altering your memory. Depending on the severity, it could reduce normal brain capacity and activity. If we were to alter the memories of said traumatic event, it would serve as damage control and possibly reverse some of the destructive and negative influences it could have on our brains.

**KEYWORDS:** Memory-altering, PTSD, amygdala, hippocampus, prefrontal cortex, neurogenesis.

## INTRODUCTION

When a person faces traumatic events, their brain usually represses memories that significantly reduces brain capacity and activity. Neuroscientists have researched and discovered that there are many reasons as to why our brain isn't able to process these events and why our memory can be one of the casualties of it (Brito, 2019). There have been many solutions, like therapy. However, not everyone would find therapy beneficial due to the differences in their situations and personalities. This raises the question: if our brain can unintentionally alter our memories, why can't we intentionally do it to help us?

## Materials & Methods

- Primary: under primary research, A neurologist has been interviewed for a more professional opinion on memory alteration and its applications in the future.
- Secondary: Scholarly articles about the brain and its functions were consulted. Information was obtained through secondary sources but was discussed and evaluated through primary sources.

## Background Information

### 1. Why does our brain alter memories?

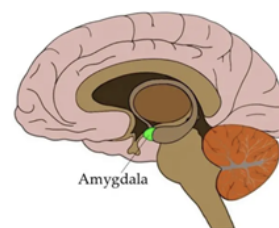
Our brain is like a processor, it processes information and memories and stores valuable moments and pieces of data. When this "processor" faces an unfamiliar obstacle (traumatic event of some sort) it glitches and cannot comprehend what's happening. As a result, our brain tends to unintentionally alter our memories regarding that specific event which may have caused harm to you or frightened you. Why this happens could be for many reasons still being studied, such as an impulse or a reaction is similar to the flight or fight reaction. It could also simply be one's brain trying to protect them from said trauma.

When Cortisol and other stress hormones like Adrenaline significantly increase due to traumatic events, it harms specific regions of our brain like the prefrontal cortex, hippocampus and amygdala (Arnsten, 2009).

### 2. Understanding the brain

Virtually, we use our entire brain on a daily basis to function and conduct daily tasks. Just like everything, our brain is also a part of a system and is a system itself. Even if one part were to fail, it would be very hard for the rest of the brain to cope and adjust. There are three main areas which get influenced by PTSD; the amygdala (processing of negative emotions), the hippocampus ("memory center") and the prefrontal cortex (cognitive functions) (Queensland Brain Institute, n.d.).

**Amygdala:** The amygdala is a small almond-shaped organ located under the hemispheres of our brain. It is in charge of processing negative emotions and activating the flight or fight response. The fight or flight response is activated when our brain senses danger; it's activated to protect us and prepare us to either fight or flee. The amygdala also has a part in memory as it stores memories which support or contain negative emotions such as fear (Guy-Evans, 2023).



**The hippocampus:** The hippocampus is a small, seahorse-shaped brain system which is located in the temporal lobe. It is associated with memory and learning as it is involved in storing long-term memory. The hippocampus is supposedly responsible for making these memories resistant to forgetting but that is a function which is argued upon. If any harm is inflicted upon the hippocampus, it can cause amnesia, which causes you to forget memories and prevent you from making new ones (Spanò et al., 2020).

According to research, our hippocampus can shrink due to excessive stress. This can potentially be reversed and repaired with the help of activating neurogenesis and neuroplasticity (Eun Joo et al, 2015; Bremner, 2006).

**Prefrontal Cortex:** The pre-frontal cortex has a big role in cognitive and control functions. It also controls some hormones like dopamine, controls prospective memory and is a place where short-term memory is stored (Eun Joo et al, 2015).

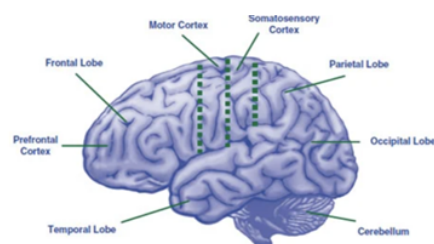


Figure 1.1 The major exterior regions of the brain.

### 3. What is Neurogenesis?

Neurogenesis can be described as the creation of new neurons. Many studies have shown that neurogenesis can help improve learning capabilities and memory recollection as it stimulates the hippocampus (Klein et al., 2017). Neurogenesis can be stimulated by aerobic exercises and learning new things; this could help improve memory recollection (Sukyu et al., 2015).

**The purpose of this paper is to answer the following:**

- Is memory alteration possible?
- What is the relation between emotion and memory?

### 4. Different types of memories.

There are 4 main types of memories (Klein et al., 2020).

<b>Short-term Memory</b>	Short-term memory is remembering a certain amount of information in small intervals of time (usually seconds)
<b>Long Term Memory</b>	Long-term memory stores specific pieces of information of an event for long periods of time. It can also take important pieces of information from short-term memory and create long-lasting memories from them
<b>Working Memory</b>	When you are working on a task, working memory is when you remember something related to what you are focusing on.
<b>Sensory Memory</b>	Sensory memory comes from the five sensory feelings; sound, feel, smell, sight, and taste. Sensory memories last a few seconds and the least and focus on your ability to process, understand and recall what you see and the environment around you.

## Research & Findings

### Trauma and Memory, What's the link?

We know that our hippocampus can shrink; this is caused due to excessive stress caused by a variety of reasons. Studies show that globally, 72% of people are facing stress (Patterson, 2022). Even though there may be many reasons for this stress, the majority of it is usually caused by trauma, and they may be suffering from PTSD (post-traumatic stress disorder). 5 out of every 100 adults suffer from PTSD (U.S. Department of Veteran Affairs, 2023), and given these statistics, we can come to a consensus that because of PTSD, we can lose our memory.

One common but very destructive coping mechanism for mental illnesses like PTSD is denial. Many people live in denial to run away from the trauma; this is known as memory repression. When trauma is too much or too severe to handle, people repress or disassociate themselves from the specific memory. This is one of the main causes of memory loss (Hanson-Baiden, 2022). In addition to that, researchers have discovered that you can develop PTSD because of repressing a memory and that you don't have to remember the traumatic memory itself to develop severe cases of PTSD. Memory repression is a defense mechanism to protect your brain from harm, it's similar to the purpose of the amygdala in the brain except memory repression is a way to detach yourself and run away. This is harmful for many reasons, for one it causes memory loss, but it also has harmful symptoms which you wouldn't be able to notice because of living in constant denial and fear of acceptance. Another harmful impact is that if this memory is somehow triggered in the future, it could have devastating impacts on not only your mental health but also your physical health, depending on the severity of the reaction.

As discussed, PTSD is very harmful to our brains. PTSD can lead to brain damage and obstacles in brain development and growth. The problem is PTSD but how do we cope with it? The world has had many different solutions towards this problem. A slow but progressive one is therapy. Addictive and destructive 'solutions' include drugs and alcohol. Even though therapy has been used as the primary treatment (perhaps the only treatment) for PTSD and other mental illnesses for a long time, it does not necessarily work for all patients. Therapy is slow and it takes time, and despite its 75% success rate (Parekh & Givon, 2019), it's not applicable to everyone. Therapy is everyone's first option because there aren't anymore, but what if memory alteration could be one?

Memory Alteration is much faster in comparison to therapy and it could yield more definitive results. We just need to figure out how we can apply it. Another coping Mechanism for PTSD and other mental illnesses is our brain inadvertently altering our memories to protect ourselves, it's healthier in comparison to repressing the memories, but still harmful. Research shows that the emotions we are feeling during an event can influence the memory of the event (Hermans, 2014). If our Amygdala gets overloaded with negative emotions, does this mean that those emotions can influence that memory? According to studies, when we get emotional, our amygdala secretes adrenaline which helps us remember events or things that happened or occurred in that specific time period more clearly and sharper (Wendt & Begum, 2022). So, in a situation where adrenaline is secreted and you remember a very traumatic event at a rate which is much clearer than your normal memory, would your brain automatically alter it to protect you? This may be automatic, or natural. The amygdala processes mainly negative emotions. Some intense emotions such as anger, fear or even sadness are sometimes the cause of memory loss as they could lead to stress, this could cause an overload of emotions for the amygdala and lead to actual alteration or natural erasure of some emotions which are linked to specifically intense negative emotions. With these findings, we can arrive at one viable point: if our brain can alter

memories without us knowing, that means that we can too. We only need to figure out how to, and how to control it.

## Discussion

Interview snippet with neurologist "Dr Ashutosh Shetty"

According to Dr Shetty, "Memory can be altered, it's possible. Memory is processed from the visual and verbal stimulus which gets encoded in your brain and if you get proper sleep, it gets stored in one of the memory areas there are many environmental factors which help in encoding and storing memory. Memory encoding is dependent on your storage and your attention span. If your attention span is good, then short-term memory can be manipulated but if your encoding or retrieval storage is good, then, long-term memory can be more easily manipulated. Memory Alteration as a treatment for PTSD depends on what symptoms they are facing, if it's more behavioral, then it won't help that much but it'll help them with dealing with stress disorders".

Memory can be altered. However, to reach that point, we need to understand how memory is encoded, and how we can hack it. When we form a new memory, the information is directed towards the hippocampus. In the hippocampus, it links all the relative parts of information and creates a new memory by creating new synapses. There are 3 types of memory encoding; Visual, Acoustic and Semantic. The strength of that memory is dependent on environmental factors and whether our short-term memory or long-term memory is stronger.

## Morals & Ethics

All technology can be misused and abused. If memory alteration technology is further developed, it is possible that it could be manipulated or misused. To prevent this, it should be used for therapeutic purposes only (treating mental illnesses). Is it ethically correct to alter memories? If a patient is unwilling to alter their memories, then it is unethical but if a patient gives consent, this technology would only be used for medicinal purposes.

This technology can help victims of trauma and mental illnesses deal with their emotional baggage in a quicker manner with more effective results. Depending on their symptoms and severity, the different types of memory can be altered (short/long-term memories).

## Conclusion

We can conclude with two main takeaways; 1) memory alteration is possible 2) it can be used to treat PTSD and other mental illnesses depending on the symptoms faced. Although it can't completely reverse the behavioral damage which has already been caused by the trauma, it can help deal with the stress and negative emotions and feelings caused by the trauma. With this link between PTSD and memory, we can see causation and correlation between these variables. Even though the influences can't completely be changed, Memory alteration as a treatment would be much more efficient than our brain's own coping mechanisms for dealing with trauma; Memory repression would be much quicker than one of the only treatments we currently have available; therapy. Since our emotions influence our memories, if there was a situation where a person was feeling negative emotions due to a specific event which occurred in a short period of time, we can figure out how to automatically alter memories based on set conditions. Anything which can be coded can be hacked. We are still far from developing technologies like this for treatments, but, this information itself is substantial enough to try and figure out more about memory storage and how our brain functions. We already know that stress and memory are related and to an extent of stress, it could negatively affect memory. However, the link between those two concepts is more important and the link, or solution, may as well be Memory Alteration.

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